January 6, 1853.

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A paper was read, entitled "On Molecular Influences. Sect. I. Transmission of Heat through Organic Structures." By John Tyndall, F.R.S. Received Oct. 20, 1852.

In this paper the author has examined the influence exerted by the molecular structure of wood upon the passage of heat through the substance. Finding the usual modes of determining the conductivity of bodies inadequate to his purpose, he has been led to the construction of a new instrument which is capable of indicating very slight differences of transmissive power.

A cubical space is cut out of the centre of a rectangular slab of mahogany. The same slab holds a thermo-electric pair of bismuth and antimony, which are fixed in trenches cut out to receive them. The junction of the pair (which is of a V-shape) abuts upon one of the faces of the cubical space just mentioned; the end of a wooden slider forms the opposite boundary of the cubical space, and against this end a platinum wire, bent several times up and down so as to form a kind of micrometer-grating, is laid and imbedded in the wood. A small projection of ivory abuts at each side of the bismuth and antimony junction, and from one projection to the other a thin membrane is drawn, thus enclosing a space in front of the junction, which is filled with mercury. Two similar projections jut at the sides of the micrometer-grating, and across from one projection to the other, a second membrane is stretched, thus enclosing another chamber in front of the wire. This chamber is also filled with mercury, and against the wire a thin plate of mica is cemented, thus preventing all contact between the two metals. From the free ends of the bismuth and antimony bars wires proceed to a delicate galvanometer.

The substances to be examined by this instrument are reduced to the cubical form and placed between the two membranes; the slider being brought closely up against the cube, the latter is clasped firmly between the rigid projections before-named. The membranes are pressed gently against the two opposite faces of the cube by the mercury behind, and thus a contact is secured which, as the mercury is not changed during an entire series of experiments, remains perfectly constant. This is a most important point in experiments of this nature, for when the conditions of contact vary in even a slight degree, comparable results are out of the question. This remark of course applies exclusively to an inquiry like the present, where the object is to detect minute differences of molecular action. The protruding ends of the micrometer-wire are united to the poles of a small galvanic battery, and the wire is heated by the passage of the current; the heat is transmitted through the film of mica to the mass of mercury in front, which thus becomes the source of heat immediately applied to the face of the cube. The current is permitted to circulate through the bent wire for 60 seconds. During this time the heat passes from the face of the cube in contact with

the source to the opposite face; the quantity transmitted to the opposite face at the end of a minute, will of course depend on the conductivity of the body in the given direction. This quantity is measured by its effect upon the galvanometer.

The temperature of the source will, of course, depend upon the amount of electricity transmitted through the bent wire, and to preserve this amount perfectly constant from day to day, a tangent galvanometer and rheostat are introduced into the voltaic circuit; a current which produces the invariable deflection of 35° is made use of to heat the wire. By this arrangement experiments which are separated from each other by long intervals of time are rendered strictly comparable.

In the manner above indicated, the author has submitted fifty-four different kinds of wood, both English and foreign, to examination. The cubes were taken so that four faces of each were parallel to the fibre, and the remaining two consequently perpendicular to it. Of the four parallel to the fibre, two opposite ones were parallel to the ligneous layers, and the other two perpendicular to them. The amount of heat transmitted in 60 seconds across the mass of each cube in these three directions, respectively, was determined in the way described, and the following law of action established:—

At all points except the centre of the tree, wood possesses three unequal axes of calorific conduction which are at right angles to each other. The first and greatest axis is parallel to the fibre; the second axis is perpendicular to the fibre, and to the annual layers of the wood; while the third and least axis is perpendicular to the fibres and parallel to the layers. It is observed that these axes of calorific conduction coincide in order of magnitude and in direction with the axes of elasticity discovered by Savart.

The author furthermore points out the existence of two other systems of axes in wood,—the axes of cohesion and the axes of fluid permeability, both of which coincide with the axes of calorific conduction.

Experiments have been made on the conductivity of various other bodies, and the non-conducting powers of the substances which enter into the composition of organic tissues is strikingly exhibited. From comparative experiments with quartz and some other substances, the author points out the influence which a mass of silica exposed to the sun's rays, as in the African deserts, must exert upon climate.

The paper concludes with experiments on some other organic structures: Tooth of Walrus, Tooth of Elephant, Whalebone, Rhinoceros's-horn, Cow's-horn; and which show how small is their transmissive power: that of sealing-wax, bees'-wax, sole-leather, glue, gutta-percha, India-rubber, filbert-kernel, almond-kernel, boiled ham-muscle, raw veal-muscle, appears to be unappreciable by the method described.